However many times material atoms may be hyper-attenuated or condensed, their substance no doubt retains its original material *status*, although removed by numbers of grades or orders of attenuation from it to which the mathematical principles of the theory assign no limit; and boundless space is thus strewn at once with a grade of common-matter atoms, which in their original *status* may have properly belonged to any other grade of unknown remoteness. But this fixity of matter's original grades of size and density with only infinite insulations from other grades, is not more notable than the unrotativeness or fixed directions of some coordinate axes of mechanical motions in space which does not prevent the motions from being just as perfectly describable by the selection of any other equally fixed ones. We are in the same way unable to say by how many revolutions the hands of a clock have reached a certain position on its dial, unless we examine and properly employ to estimate it the state of wear and attrition of the wheel-work of the clock's driving train, or unless we know the number of times that the clock had been wound up.

The solution of some very bewildering physical questions is offered by this hypothesis[1] when we reflect, as I have before endeavoured to explain, that the expansions here considered are all of them variations of a quantity ϕ (or "entropy" of a homogeneous body at the same temperature throughout), which, by its mathematical description, is obviously the ratio index of a describing point's place upon a hyperbola, and which therefore passes continuously through an endless series of values 0 and ∞ (which revisit each other in graphic space, just as a circle-radius revisits its former place after every passage through four successive right angles), while the describing point pursues the curve continuously.

There is enough evidence in geometry to show that this hyperbolic variable of position, and the angular one on the hyperbola's auxiliary circle of a certain configurated point on that circle, cannot pursue their geometrically configurated course together through more than a quadrant of the circle and hyperbola from the two curves' common apex without violating the axioms of ordinary geometry. Thus it is clear that in the transition state of the measure ϕ through infinity from one "grade" of a mass's state of attenuation to another, there is needed a new law of geometry (or at least of continuous material motion) allowing a new pair of tracing-points supplanting the disused former pair at each dead-point of the two curves, to describe a new quadrant of the hyperbola and of its auxiliary circle from that point, with a constant geometrical configuration to each other without violating geometrical axioms.

This transition law and the nature of the configuration which it frees from geometrical contradictions while giving it continuous validity round the whole circuit of the circle and hyperbola together, is so exactly what has just been described of the nature of material points' or of physical integrant-parts' compositeness while still remaining points in their motor properties, that almost all reason for doubt and question seems to be excluded that it is the sought-for law and mode of motor connection between θ and ϕ (or angle- and entropy-position of a point or homogeneous body), which links universal heat-motion of matter to all those other, no doubt therefrom derivable but otherwise unaccountable descriptions of matter's motions which we see in physics.

[1] In particular, as will be easily gathered from the above brief comments, of the law of dissipation or of a fixed tendency to gradual reduction and to universal uniform diffusion of all forms of energy *in a given link* of matter's grades in one common form of the energy of heat, or of the work of entropy-expansion.

On Lord Rayleigh's Dark Plane

IN NATURE, vol. xxviii. p. 139, was printed a communication from Lord Rayleigh to the Royal Society on the subject of the dark plane which is seen above hot bodies in dusty and illuminated air, and which had long been used by Tyndall, and after him by science teachers generally, as an illustration of the fact that light which does not enter the eye cannot be seen.

It had never occurred to me to doubt the validity of the commonly-received explanation of the dust-free space, viz. that the dust in the dark region had been either burnt up or dried up by contact with the hot body, and I was struck and greatly interested in the definite character of the phenomenon as described by Lord Rayleigh in your pages, and in his conclusive shattering of the old explanation by the simple device of using a cold body instead of a hot, and so getting a down-streaming dust-free space instead of an up-streaming.

I was however quite unable to accept Lord Rayleigh's very tentative hypothesis that the curvature of the stream-lines and consequent centrifugal actions might possibly account for the phenomenon, nor do I imagine that he himself ever regarded this as anything more than a guess thrown out for want of a better.

I mentioned the matter to Mr. J. W. Clark, whose services as Demonstrator I have lately had the good fortune to secure, and he proceeded to make a few simple experiments with a view first of repeating the observation, and next of testing an electrical hypothesis which suggested itself.

The hypothesis is one that has failed to verify itself, but it may be just worth stating. The difference of temperature between the solid and the air causes convection currents, the air thus made to stream over the surface of the solid electrifies itself by friction, and the dust particles are expelled from the electrified air.

We were early led to doubt whether the insignificant amount of friction which alone was acting in some cases could possibly produce the effect; and in fact it was soon found that though electrification modified the phenomenon it pretty certainly did not cause it.

A doubt then arose whether the space was actually dust free or only optically so; whether anything like mirage due to unequal densities could account for the darkness. These ideas, however, would not bear consideration, and we soon convinced ourselves that the region is really transparent air free from dust, though its extreme sharpness and blackness render it difficult at times to refrain from thinking of it as a black opaque film.

Irregular dark striæ obviously allied to the regular dark plane are to be perpetually observed in any dusty air disturbed by convection currents; and nothing but the want of the necessary illumination prevents our commonly observing what must be one of the most universal appearances, viz. dust-free regions streaming from every solid body.

We are now pretty well convinced that differences of temperature have nothing to do with the real nature of the phenomenon; *we find that solid bodies have sharply-defined dust-free coats or films of uniform thickness always surrounding them*, and that these coats can be continually taken off them, and as continually renewed, by any current of air. The slightest elevation of temperature of the solid causes its dark coat to stream upwards; the slightest depression of temperature below that of the atmosphere causes the coat to stream downwards; but the coat is there all the time, independent of convection currents, though I believe it gets thicker as the body gets warmer. *Why* the air near a solid is free from dust we are not prepared to say.

A few of our earlier experiments might readily enough have suggested the old exploded explanation that the smoke was either burnt up or dried up or otherwise temporarily rendered invisible by heat. Take for instance a long piece of ordinary quill glass tubing; blow it half full of tobacco-smoke, and hold it horizontally in a beam of light. The first thing to notice is the curious way the end of the stream of smoke draws out to a point with a sharply defined edge, and how it falls about inside the tube when the tube is rotated. Next warm a part of the tube gently: a space clear of smoke at once appears and widens. Next heat the tube in the flame of a Bunsen and blow smoke gently and continually through it: the smoke narrows down to a mere thread as it passes the hot place, or it may disappear altogether in a pointed cone; but it reappears on the other side of the hot place, and it issues from the end of the tube.

Our experiments have been mostly conducted in a glazed cigar-box with one or more horizontal copper rods passing into it through insulating glass tubes, the ends of the rods carrying binding-screws into which could be clamped scraps of sheet copper of various shapes. The illumination was either sunlight or an oxyhydrogen lamp, or more usually, and far the most conveniently, a Serrin arc-lamp in its lantern, fed by a secondary battery. The smoke employed was nearly always tobacco, for we soon satisfied ourselves that the nature of the smoke or dust did not affect the essence of the phenomenon, and we consequently used that which was the easiest and for which the implements were always at hand. Sal-ammoniac was, however, occasionally used instead.

It was wholly unnecessary to heat the rod in order to start the dark up-current, for if it is not infinitesimally warmer than the air to begin with, the beam of light will warm it sufficiently in an instant. Still the rods can be heated by a lamp outside the

box if desired, or on the other hand their projecting ends can be bent down and immersed in a freezing mixture when a cold dark plane is wanted.

The transition from the cold down-current to the warm up-current is a thing I specially wished to observe, and it can be readily seen by first letting the rod get thoroughly cold in the dark and then turning on the light without removing the freezing mixture. The down-current is now visible, and it persists for a short time, varying from a second or two to a minute; but as the rod is warmed by the beam, it soon visibly slackens, turns round, and establishes itself as an up-current; the transition from a strong down- to a strong up-current only occupying a few seconds altogether. If the light be now interrupted for a short time, and then renewed, the down-current will be observed as before, and in fact one may make the alternations with great rapidity, permitting now the freezing mixture and now the hot beam to gain the mastery.

The turning bodily round of the dark plane is doubtless due to a general convection current produced by the warming of the glass of the box by the entering beam. The beam was, however, always filtered through water in order to bring its heating powers within manageable limits.

To witness the effect of a diminution of pressure on the phenomena, a thick platinum rod with its end beaten into a narrow spade, was sealed into an old lamp chimney closed by plane glass ends, and connected with a water air-pump on one side, and with a $CaCl_2$ tube, a tobacco pipe, and pinchcock on the other. A little exhaustion and an intermittent opening of the pinchcock was able to smoke the pipe in the orthodox manner, and the exhaustion was then proceeded with further; an accumulation of vacuum being often quickly turned on. At low pressure the dust-free space surrounding the spade became large and ill-defined, and the convection-currents were lazy and ineffective; the exhaustion was not pushed to extremes, because it was difficult to keep any smoke still suspended, but the general fact that the dark region broadened considerably under diminished pressure was fairly well made out. The coat is enormously thicker, however, than any Crookesian or free-path layer.

When examining the effects of electrification we sometimes brought electrified rods near to the dark plane, and sometimes we electrified the rod from which the plane was streaming. The latter is by far the most effective, and the results are very striking and interesting. It is not sensitive to minute differences of potential however, and it required from fifty to one hundred Leclanché's to exhibit distinct effects. We then found that positive electrification of the rod rendered the coat and the stream broader, but made their outline hazy. Connecting the rod to earth instantly sharpened it up again, making it beautifully clear and distinct. Negative electrification sharpened the outline still more, and narrowed it down still further, but the effect of positive electrification was more marked than that of negative.

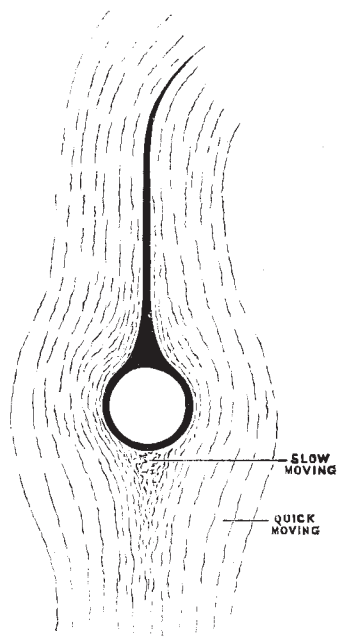
When comparatively high potentials were used, such, for instance, as would give millimetre sparks if permitted, the effects were violent. As the potential rose, the dark coat and stream broadened, and ultimately disappeared; reappearing again and closing in from each side in a curious way, so as to reestablish the clear dark plane depicted by Lord Rayleigh in his paper above-mentioned, the instant an earth contact was made. Violent negative electrification exhibits somewhat similar effects. If any brush discharge took place, there was a violent black chimney-like rush, and the whole box rapidly cleared of smoke.

The electrical effects are not easy to describe, but they are worth seeing. We sometimes used two solid brass cylinders with rounded edges screwed on to brass rods and insulated from each other, cylinders say three centims. by one; sometimes we used a cylinder and a point, sometimes two flat spades, and so on. Connecting them with the poles of a Voss-Holtz machine and turning very slowly, the change from two well defined and sharp Lord Rayleigh planes through an interval of indistinctness to vigorous and curiously-shaped black streamers is very striking. But in a few seconds all the smoke has gone; it has not been driven out of the box, it has been condensed on the box surfaces and on the electrodes, which latter soon look as if they had been lacquered by an amateur, and make yellow greasy marks on one's fingers.

Moderate positive electrification of the rod, then, widens and renders hazy the coat and the dark stream; earth connection, or still better weak negative electrification, narrows it and renders its outline beautifully sharp and distinct. The stream itself does not show signs of electrification. Obstacles in its path deflect it, and it curls round them, forming rather a pleasing stream-line illustration.

As soon as we had made out that the dark plane was continuous with a dark coat surrounding the body, we paid more attention to the coat than to the plane. It seems to me a somewhat important fact that solids have surrounding them a layer into which dust particles do not enter, of a thickness which we estimate as comparable with 1/100th of an inch, though it certainly varies with temperature, pressure, and electrical potential. We first observed the dark coat as a lining to a semi-cylindrical scrap of copper sheet held in the binding screws formerly spoken of, with the hollow turned towards the light. It can be seen quite well, however, on a simple round rod or straight thick wire; and for many reasons this is preferable. To avoid the shadow of the rod and to see the coat all round it we return the light on its path by a mirror, often also illuminating from above by means of a 45° mirror.

When the smoke is thick a feeble light is sufficient, but I prefer a thin smoke and a powerful light. After tobacco has been in the box some time, say half an hour, the smoke particles have aggregated together and can be individually seen. It is then very instructive to look along the end of the rod through a low-power microscope. The diagram attempts to illustrate the appearance.



The coat of dust-free air is perpetually being rubbed off and renewed; the attachment of it to the rod is not individual. I believe all dark striæ seen in a smoky sunbeam are the wiped-off coats of solid bodies, which, however, are now rapidly disappearing by reason of the general diffusiveness of the dust particles.

The transparent coat on the inside of a glass tube full of smoke can be seen, and when a point is heated the coat thickens and rises, making a clear dark space, and then it proceeds to roll itself up along with some of the dust into two distinct spirals one on each side of the hot place.

I have no hypothesis whatever ready to account for the dust-freeness of the film of air in contact with solids. But I believe the existence of this film, and its electrical modification, to have a close connection with various phenomena; for instance, the easier discharge from negatively electrified bodies than from positive—the dust-free coat is thinner: the convective discharge of electricity by hot bodies and its dissymmetry as observed by Guthrie, the dissymmetry of the Lichtenberg tracings, the abnormal dielectric strength of thin films of air as observed by Sir Wm. Thomson ("Reprint," chapter xix.). For I imagine that disruptive discharge would more easily commence in dusty air than in clear air, and consequently that when the sparking bodies are approached so that their dust free coats touch, the dielectric strength is likely to be great.

Maxwell indeed suggested ("Electricity," vol. i. p. 56) that a layer of extra dense air equivalent to an extra layer of ordinary air about 1/200th inch thick surrounding solids would account for Sir Wm. Thomson's remarkable and puzzling results; and this is a dimension of the same order of magnitude as the thickness of the dust-free coat on bodies at an ordinary temperature. I by no means intend to imply that the dust-free layer is not composed of extra dense air—I have no evidence on the subject—but the dust-freeness may *possibly* account for its greater strength without the hypothesis of extra density.

The dust-freeness itself remains to be accounted for. Numberless experiments suggest themselves. We have not yet tried other gases even, though that is an obvious thing to do.

It struck me some time ago that the motes in a sunbeam would be convenient weightless bodies for many purposes, to exhibit statical lines of force for instance, but the particles of the smoke we have hitherto used have not been sufficiently elongated for this purpose. But I anticipate that the examination of all kinds of electrical phenomena in the strongest possible light, instead of in the dark as usual, may lead to various fresh observations.

The rapidity with which an electrified point clears the box of smoke is so noticeable as to suggest several practical ideas. It is somewhat surprising considering the perfection to which electrostatic machines have been brought that they have not yet received any practical application. The electrical clearing of the air of smoke-rooms, or of tunnels, is perhaps not an impracticable notion. The close relationship between fogs, epidemics, &c., and the suspension of solid particles in the air, suggests the use of electrical means for sanitation, and for weather improvement. It has long been known that lightning clears the air, and though ozone may be credited with a portion of the beneficial influence, I fancy the sudden driving away of all solid particles and nuclei must have a great deal to do with it.

If the germs driven out of the air are condensed on the earth's surface, a partial explanation is suggested of the way in which "thunder turns milk sour," a fact which has always puzzled me, and which appears to be well established.

I cannot help thinking that the human race will ultimately acquire some means of artificially affecting the weather in a less injurious manner than that which they have hitherto attempted with only too great success, namely, the manufacture of solid nuclei in prodigious numbers for moisture to condense round, and of oily matter to cover the surface of such moisture with, in order to prevent its evaporation. As soon as this artificial pollution of the atmosphere has been decisively checked, it will be time to consider whether it may not be possible to keep off even natural mists and rain when they are not wanted, and to assume some sort of control over the weather at critical seasons, instead of halting between superstitious appeals to Providence on the one hand, and a helpless resignation to fate on the other, which are our attitudes at present.

Meanwhile is it not possible that a periodic optical examination of the atmosphere by a strong beam of light might convey useful meteorological information? OLIVER J. LODGE

University College, Liverpool, July 11

Antihelios

BY means of a current of air passed through an ice closet or a closet otherwise reduced in temperature the air of living-rooms might be gauged to any temperature, but say 60° or 70° F. if we pleased. If the air were driven through a preliminary water chamber arranged on the principle of the hubble-bubble pipe, mosquitoes and other flying pests would be excluded absolutely. Imagine the comfort of sitting down to a meal whereat one's food should not be hidden by flying vermin, of reposing in a cool chamber wherein these intruders should be excluded absolutely. When I lay ill of fever in West Africa the atmosphere about me felt simply like the blast from a furnace. What an element of recovery, of possible health and physical wellbeing, would it not prove in hospitals when poor fellows languishing in disease should be surrounded by pure, cool, insectless air instead of air at a hundred degrees or even higher. People—some people—say doctors do not feel, but I say that a doctor's heart is rent with anguish when he enters a chamber wherein the air is pestilential, where the sores of wounded men are maggot-infested and the men themselves are eaten up with vermin. All this cooler air would prevent or tend to prevent. The festive hall, the school-room, the living-room, the barrack, the church, would all experience, the occupants regarded, commensurate relief. It would be just as available in ships as on shore. The Red Sea transit and the blazing oceans of the tropics need no longer be things of terror. In steamships a small percentage of steam power would suffice for driving the cool air current. Wind, water, hand, and steam power could also be rendered available. The vans employed to supply blast-furnaces should suffice for anything, but there is the winnowing van which horse or mule, indeed any animal, could work. Even the simple circular bellows would keep an apartment cool. In towns or in a contonment, a stationary engine with air-ducts leading to the different dwellings would satisfactorily replace apparatus adjusted to each separate house. HENRY MACCORMAC

Belfast, July 21

Disease of Potatoes

THE paragraph in NATURE, vol. xxviii. p. 281, regarding a "hitherto unknown" disease of potatoes near Stavanger, appears to be identical in every way with the disease which destroyed the "champion" potatoes in the West of Ireland in August, 1880, described and illustrated by me in the *Gardener's Chronicle* for August 28, 1880. The bodies described by Herr Anda, as about the size of a small black bean, are *Sclerotia*, or masses of highly condensed mycelium, and they have nothing to do with the potato fungus proper, *Peronospora infestans*.

It is a remarkable fact that neither horticulturists or botanists had ever noticed these large black *Sclerotia* in potatoes in Britain before 1880, and as far as I know no one has ever seen them since. There was a prodigious and destructive growth in 1880, and several botanists as well as myself tried to make the *Sclerotia* germinate, but a failure resulted in every instance. It appears that Herr Anda has seen the *Sclerotia* germinating; it is therefore to be regretted that he has not identified, or got some one else to identify, the perfect fungus.

WORTHINGTON G. SMITH

"Waking Impressions"

I HAVE before me now a record, written the following morning, of a waking impression of the same order as that told by Mrs. Maclear in NATURE, vol. xxviii. p. 270, but which I think shows more clearly the sort of duplexity of brain action that one sometimes detects in dreams.

I awoke with a clear vision of a pamphlet I was holding. The subject was cookery, and about four-fifths of the cover was occupied by an engraving of pots and pans, trussed chickens, and other culinary matters. Below this, in one line, printed in capitals all of the same size, was the title which I was reading at the moment of awaking, "FOOD, OR THE ASTROLOGY OF EVERY DAY."

My first waking impression was of the utter irrelevance of the alternative title; but on looking at it with closed eyes more carefully I saw that the paper in one place had been rubbed, and that a little bit was curled up, leaving a wider space between "the" and "astrology" than between the other words. The conviction then came to me that a letter was missing, and that the word in full must have been "Gastrology." This of course made sense of the title; but it is curious that one's waking intelligence should be needed to interpret the inventions of one's dreams. E. HUBBARD

1, Ladbroke Terrace, July 21

A Remarkable Form of Cloud

WHILE preparing to observe the moon on Sunday, the 22nd inst., at 10h. 20m. p.m., my attention was attracted to a peculiar patch of grayish white light a few degrees from the moon, which upon closer examination I found extended right across the heavens, from the north-north-west to the south-south-east point of the horizon, passing through the zenith. It had a breadth of about 2°, and was sharply defined on both sides, more especially the northern, excepting near the zenith, where it was broken up into three or four detached cloudlike masses. All other parts of the sky were perfectly free from clouds, so that this one appeared like a gigantic arch spanning the heavens; so much so that a person to whom I pointed it out compared it to a rainbow, which it very much resembled in form. At 10h. 45m. it was reduced about one-half in width and had shifted 20° from the zenith